BEFORE THE HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of applications by Tararua District Council to Horizons Regional Council for application **APP-2005011178.01** for resource consents associated with the operation of the Eketahuna Wastewater Treatment Plant, including a discharge into the Makakahi River, a discharge to air (principally odour), and a discharge to land via pond seepage, Bridge Street, Eketahuna.

REPORT TO THE COMMISSIONERS

DR BRENT COWIE (CHAIR), MR REGINALD PROFFIT AND MR PETER CALLANDER

SUPPLEMENTERY REPORT OF LOGAN ARTHUR BROWN – FRESHWATER AND PARTNERSHIPS MANAGER

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7 APRIL 2017

A. INTRODUCTION:

1. My name is Logan Arthur Brown and I am giving evidence in these proceedings on behalf of the Manawatu-Wanganui Regional Council (Horizons Regional Council - HRC). My qualifications are stated in my previous s42A evidence to the commissioners dated 7th March 2017.

2. This supplementary evidence has been prepared to expand on areas in my s42A Report and to provide a response to matters that have been raised through expert evidence and through submitters.

3. As per my previous evidence I confirm that I have read the Environment Court's Code of Conduct for expert witnesses contained in the Environment Court Practice Note (2014) and I agree to comply with it.

B. REPORT SCOPE:

4. This report intents to cover:

   4.1. Calculations of nutrient concentrations below the 20th FEP;

   4.2. Wastewater quality monitoring standards;

   4.3. Mixing zone;

   4.4. Macroinvertebrate densities;

   4.5. Water quality at the State if Environment monitoring sites;

   4.6. SIN loads;

   4.7. Periphyton targets;

   4.8. Effects on macroinvertebrates; and

   4.9. Dissolved oxygen monitoring.

C. CALULATION OF NUTRIENT CONCENTRATIONS BELOW THE 20TH FEP

5. In my s42A report at Tables 10, 11, and 12 I had calculated the annual average in-stream concentrations for DRP, SIN, and ammonia using data that I had not excluded data collected at flows above the 20th Flow Exceedance Percentile (FEP) from. Dr Ausseil in his evidence raised the fact that the One Plan nutrient targets exclude samples that are collected above the 20th FEP in any analysis. This is correct and is based on the assumption that during flows above the 20th FEP that periphyton is removed from substrate (or is unable to grow). Therefore for technical correctness to assess the water quality data against the One Plan I have redone the analysis that was included in my s42A report, this time excluding samples that were collected above the 20th FEP. The flow site used in the analysis is Makakahi at Hamua which is approximately 11.5 kilometres downstream of the Eketahuna STP. I have redone the assessment below using the same tables from s42A report to enable people to see the difference between the s42A report and the reworked numbers:

Table 11: An assessment of the Makakahi at downstream of the Eketahuna WWTP discharge against the One Plan targets. Red non-complies with the One Plan target, Green complies with the One Plan target.

	SIN (g/m^3)	DRP (g/m^3)	Ammonia (g/m^3)
2012	0.363	0.0067	0.015
2013	0.449	0.0086	0.019
2014	0.426	0.0069	0.008
2015	0.472	0.0095	0.0091
2016	0.545	0.0099	0.0205

6. The data showing that the Makakahi at downstream of the Eketahuna WWTP discharge doesn't met the One Plan targets for SIN on 3 out of 5 years, but does met it for ammonia, DRP, and SIN on two out of three years.

7. Table 12 shows an assessment for Ngatahaka upstream of the Makakahi confluence against the One Plan targets for SIN, DRP, and ammonia.

Table 12: An assessment of the Ngatahaka upstream of the Makakahi confluence against the One Plan targets. Red non-complies with the One Plan target, Green complies with the One Plan target.

	SIN (g/m³)	DRP (g/m³)	Ammonia(g/m³)
2012	0.753	0.0074	0.009
2013	0.832	0.0083	0.0299
2014	0.940	0.0071	0.0146
2015	0.892	0.0093	0.0081
2016	0.899	0.008	0.006

8. The data showing that the Ngatahaka at upstream Makakahi confluence doesn't meet the One Plan targets for SIN but does meet it for ammonia and DRP.

9. Table 13 shows an assessment for Makakahi at upstream of the Eketahuna WWTP discharge against the One Plan targets for SIN, DRP, and ammonia.

Table 13: An assessment of the Makakahi at upstream of the Eketahuna WWTP discharge against the One Plan targets. Red non-complies with the One Plan target, Green complies with the One Plan target.

	SIN (g/m³)	DRP(g/m³)	Ammonia (g/m³)
2012	0.177	0.0038	0.0103
2013	0.246	0.005	0.0098
2014	0.196	0.006	0.0128
2015	0.232	0.004	0.005
2016	0.242	0.005	0.005

10. The data showing that the Makakahi at upstream of the Eketahuna WWTP discharge meets the One Plan targets for SIN, DRP, and ammonia.

11. However, further work has been done since the One Plan 20th FEP was proposed and we now know that this assumption is incorrect for some rivers in the region including the Makakahi River. Joint work undertaken by NIWA and Horizons has shown that for the Makakahi at Hamua a flow above 38.1 m3/s is needed to remove periphyton. Table 1 below contains the results of the analysis that has been undertaken that shows the flows required to remove periphyton in some of the regions rivers.

Table 1. Summary of flows required to initiate key mechanisms of periphyton removal, along with the estimated threshold flows for periphyton removal (Q_{pr}) and the median flow (Q_{50}). The frequency of sand mobility and D_{50} mobility is presented as the percentage of days that flows are greater than flows required to initiate mobility. Sites with a QD_{50} of 'none' are those where bankfull flow is not competent to mobilise the D_{50}.

Site	Q_{sand} (m^3/s)	Q_{D50} (m^3/s)	Q_{pr} (m^3/s)	Q_{50} (m^3/s)	Q_{pr}/Q_{50}	Q_{sand}/Q_{50}	% days > Q_{sand}	% days > Q_{D50}
Waikawa at North Manakau Rd	3.0	6.5	6.4	0.88	7.3	*3.4*	16%	6%
Oroua at Almadale	1.6	2.4	17.9	6.06	3.0	*0.3*	93%	85%
Kumeti at Te Rehunga	0.2	0.9	0.6	0.31	1.9	*0.5*	80%	13%
Rangitikei at Mangaweka	248.0	345.0	318.6	45.25	7.0	*5.5*	4%	2%
Rangitikei at Pukeokahu	143.7	none	158.5	16.73	9.5	*8.6*	3%	0%
Mangapapa at Troup Road	1.0	2.48	4.0	0.33	12.2	*3.1*	27%	10%
Rangitikei at Onepuhi	148.3	225.0	101.7	48.57	2.1	*3.1*	15%	8%
Mangawhero at Pakihi Rd Br	8.7	22.3	15.7	3.30	4.8	*2.6*	15%	3%
Manawatu at Upper Gorge	146.0	375.0	155.8	51.11	3.0	*2.9*	21%	5%
Rangitikei at McKelvies	93.9	129.9	98.2	46.41	2.1	*2.0*	30%	19%
Manawatu at Teachers College	100.8	162.0	129.2	65.76	2.0	*1.5*	41%	24%
Oruakeretaki at SH2	1.0	3.0	2.3	1.39	1.7	*0.7*	70%	23%
Tamaki at Stephensons	2.3	5.6	4.5	2.25	2.0	*1.0*	55%	20%
Makotuku at Raetihi	10.3	60.9	10.5	0.73	14.5	*14.2*	5%	0%
Makakahi at Hamua	25.0	70.0	38.1	3.14	12.1	*8.0*	7%	2%
Tiraumea at Ngaturi	77.0	none	46.6	7.13	6.5	*10.8*	6%	0%
Makuri at Tuscan Hills	26.0	107.7	40.8	3.49	11.7	*7.4*	6%	0%
Manawatu at Hopelands	32.7	78.7	33.2	15.05	2.2	*2.2*	28%	10%

12. One additional factor to point out here is also the way that Dr Ausseil has assessed compliance with the One Plan targets. The One Plan targets for SIN and DRP are expressed as an annual average i.e. that the analysis is undertake on data collected over the last 12 months (usually monthly samples given the sampling regime that Horizons runs for SOE and discharge water quality monitoring). I note that this is slightly different to the way that Dr Ausseil calculates it with his analysis including all data and taking the average. The disadvantage of doing the analysis this way is that if large changes are made in the catchment i.e. removal of wastewater to land, treatment plant upgrades these will take years to follow through into data sets. The calculation of the annual average will only take 12 months.

13. In addition the reliance on calculating the annual average to infer periphyton growth is always risky as it is the nutrient concentrations during the accrual phase of periphyton

that dictates what the biomass will be at any point in time. Therefore during low flows when point source inputs are generally more prominently seen in water quality results the effects on periphyton growth are more pronounced.

D. WASTEWATER QUALITY MONITORING STANDARDS

14. Questions during the hearing process have been raised around the effluent quality standards and the wastewater monitoring guidelines. These guidelines are becoming more frequently used in resource consents within the Horizons region. The only resource consent process that has been through the entire process to date using these protocols/standards for compliance is the Feilding WWTP. The standards that were developed for the Feilding WWTP were permissive in their approach in that they favoured the discharger. It has recently come to my attention that it is also possible to use either the permissive approach as done in Feilding or a precautionary approach. To date I'm not aware of the use of the precautionary approach in the Horizons region. However, as the name implies this approach favours the receiving environment. I have no set opinion on which is the most appropriate to use but I believe that it is important that the panel is aware of the different approaches that could be used. One downside to the precautionary approach is that it would require monitoring to be undertaken on a more frequent basis such as weekly or fortnightly to allow compliance to be assessed in a timely manner.

15. I have included Table 1, Appendix 1 which will allow the panel to chose which is considered most appropriate if you believe that the conditions are appropriate. The proposed conditions would remain the same but the number of exceedances that would be allowed to happen will change depending on the approach used. As an example for the permissive approach "The concentration of Ammonical-nitrogen (NH4-N) shall not exceed xx g/m3 in more than 8 out of 12 consecutive samples, and no more than xx g/m3 in more than 2 out of 12 consecutive samples" and for the precautionary approach "The concentration of Ammonical-nitrogen (NH4-N) shall not exceed xx g/m3 in more than 23 out of 60 consecutive samples, and no more than xx g/m3 in more than 1 out of 77 consecutive samples".

E. MIXING ZONE

16. The evidence of Ms McArthur and also the supplementary evidence of Dr Ausseil covers the issue of the mixing zone. I agree that depending on the locality of the discharge point then the mixing zone will only need to be approximately 100 metres for reasonable mixing to occur.

F. MACROINVERTEBRATE DENSITIES

17. Questions were asked during the presentation of Ms McArthur's evidence around the densities of the macroinvertebrates at the monitoring sites associated with the current discharge. Table 2 below shows the total number of macroinvertebrates that were captured from the 5 surber samples that were collected at each of the sites.

18. The data showing that the density of macroinvertebrates at the most downstream site is consistently higher than the two upstream sites across all the years that monitoring has been undertaken.

Table 2: Macroinvertebrate densities from the 5 surber samples collect at the Makakahi upstream of the WWTP, Ngatahaka upstream of the Makakahi confluence, and the Makakahi downstream of the WWTP.

	U/S Makakahi	**Ngatahaka**	**D/S Makakahi**
2016	2432	1726	4218
2015	632	1082	1813
2014	1126	2237	5202
2013	3186	2712	5215

G. WATER QAULITY AT THE STATE OF THE ENVIRONMENT MONITORING SITES

19. In the evidence of Ms McArthur comment was made on a lack of an assessment being undertaken for monitoring sites outside of those associated with the discharge for water quality. I have undertaken this assessment below – this assessment has been undertaken for the Makakahi at DOC and Hamua sites for DRP and SIN.

20. The analysis is shown in Table 3 below (excluding data when flows were above the 20^{th} FEP). The data shows that the Makakahi at DOC meets the One Plan target for DRP and SIN and that the Makakahi at Hamua meets the One Plan target for DRP and in 2 out of the 5 years for SIN (doesn't meet it on 3 out of 5 years).

Table 3: Annual average concentrations of DRP and SIN in the Makakahi River at Hamua and the DOC monitoring sites in the Makakahi catchment. Samples taken above the 20th FEP are excluded from the analysis.

	Makakahi at Hamua			Makakahi at DOC		
	Count of samples	SIN (g/m^3)	DRP (g/m^3)	Count of samples	SIN (g/m^3)	DRP (g/m^3)
2012	9	0.410	0.006			
2013	12	0.460	0.008	5	0.030	0.009
2014	11	0.428	0.006	11	0.031	0.008
2015	11	0.479	0.004	11	0.031	0.005
2016	9	0.556	0.006	7	0.049	0.006

H. SIN LOADS

21. The evidence of Dr Ausseil usefully provides the loads of DRP and SIN that are discharged to the Makakahi as a result of the discharge. One thing to note here (and which I have had confirmation from Dr Ausseil) is that the loads for the whole period do not exclude the load that travels down the river when it is above the 20th FEP. This is quite different to the analysis that Dr Ausseil has undertaken for the concentrations in-stream that exclude the samples collected at flows above 20th FEP. This means that the loads experienced in the river below the 20th FEP will sit somewhere between the all data and the low flow data. This is important as some of the discussion that Dr Ausseil showed in the presentation and following discussion was around the linkage between the loads and concentrations but we are not completely comparing apples with apples so this needs to be keep in mind that the point source contribution to loads would be larger if we excluded the loads above the 20th FEP from the analysis.

I. PERIPHYTON TARGETS

22. During the hearing questions have been raised around the relationship between the periphyton coverage targets and the change in QMCI. During the development of the One Plan the visual coverage targets were set around aesthetics and peoples enjoyment of the river. There was however, no relationship between coverage and a change in QMCI.

23. In questioning Dr Ausseil has made reference to the chlorophyll a target and the level of error that exists around the sampling of chlorophyll a within rivers. Error is not unique to chlorophyll a monitoring and exists across all water quality parameters that are monitored. The monitoring undertaken as part of all of Horizons programmes all follow best practice and therefore the error encountered in monitoring would be no

different to other water quality monitoring procedures. In addition this error works both ways with unders and overs occurring.

J. EFFECTS ON MACROINVERTEBRATES

24. Dr Ausseil has covered in detail the potential causes of the changes in macroinvertebrates communities at the downstream point. What I wanted to cover in a little more detail is the coverage of phormidium at the time that the macroinvertebrate samples were collected. Dr Ausseil usefully provides at Figure 20 in his evidence what the mat (phormidium) coverage is at each of the sites. Horizons is currently leading a monitoring programme that is looking at the effects of phormidium on macroinvertebrate communities. Although the programme has not yet been completed there are preliminary results that show that the presence of phormidium changes (depresses) the QMCI compared to sites that do not have phormidium present. Although perhaps not that surprising it could be one of the factors that influences the macroinvertebrate communities downstream of the discharge point. If we look at Figure 20 in Dr Ausseil's evidence that at the times that the macroinvertebrate samples are taken the phormidium coverage at the site is also higher.

25. The presence of phormidium at the upstream sites is lower than the downstream site. In terms of how this follows through to this application. Research to date shows that phormidium growth is generally associated with elevated SIN levels and lows DRP levels.

K. DISSOLVED OXYGEN MONITORING

26. To enable to an accurate assessment to be undertaken with compliance with both the DO target in the One Plan and the Freshwater NPS attribute continuous monitoring would need to occur. This monitoring would need to be tied to low, stable flows in the river and would need to be for a minimum of a week. In addition I note that during the evidence of Dr Ausseil he raised the possibility that the settling out of POM onto the streambed may result in it's decomposition and therefore changes the DO levels at the bed. This is a plausible explanation but monitoring in the water column itself would not result in answering this question. These effects will be seen at the bed level (were the macroinvertebrates live) and monitoring would need to occur at the bed level to monitor the effects on the macroinvertebrates.

27. During the presentation of evidence by Ms McArthur a reference was made to a report called the Temporal Variability in Ecosystem Metabolism of Rivers in the Manawatu-

Whanganui Region – Updated (Young and Clapcott, 2009). The Mangatainoka at Town Bridge was included in this survey and the following is taken from the executive summary for this site *"Rates of GPP and ecosystem respiration (ER) in the Manawatu River at Teachers College and Mangatainoka at Pahiatua suggested good-satisfactory health in autumn, winter, and spring, but were indicative of poor ecosystem health in summer."*

28. In addition in the discussion states *"Dissolved oxygen data analysed in this study shows that the dissolved oxygen standards in the Proposed One Plan are being breached on a relatively regular basis at the Manawatu at Hopelands and Mangatainoka at Pahiatua sites (Table 2). The minimum DO saturation observed at the Manawatu at Hopelands site (34% Saturation) corresponded with a DO concentration of 3 mg/L. Sensitive fish would not be expected to live long under these conditions (Dean & Richardson 1999). Although also breaching the proposed DO standards, the minimum DO saturation observed in the Mangatainoka River at Pahiatua (65% Saturation) corresponded to a DO concentration of 6.3 mg/L. Immediate fish mortality would not be expected at this higher concentration and any effects at this site would be more likely related to fish health, growth, reproduction and long-term survival (BCME 1997)."*

29. As well as the monitoring that was undertaken as part of this survey Horizons monitors DO continuously at the Managatainoka at Town Bridge. During summer this site can experience low DO concentrations as shown in the Figure below.

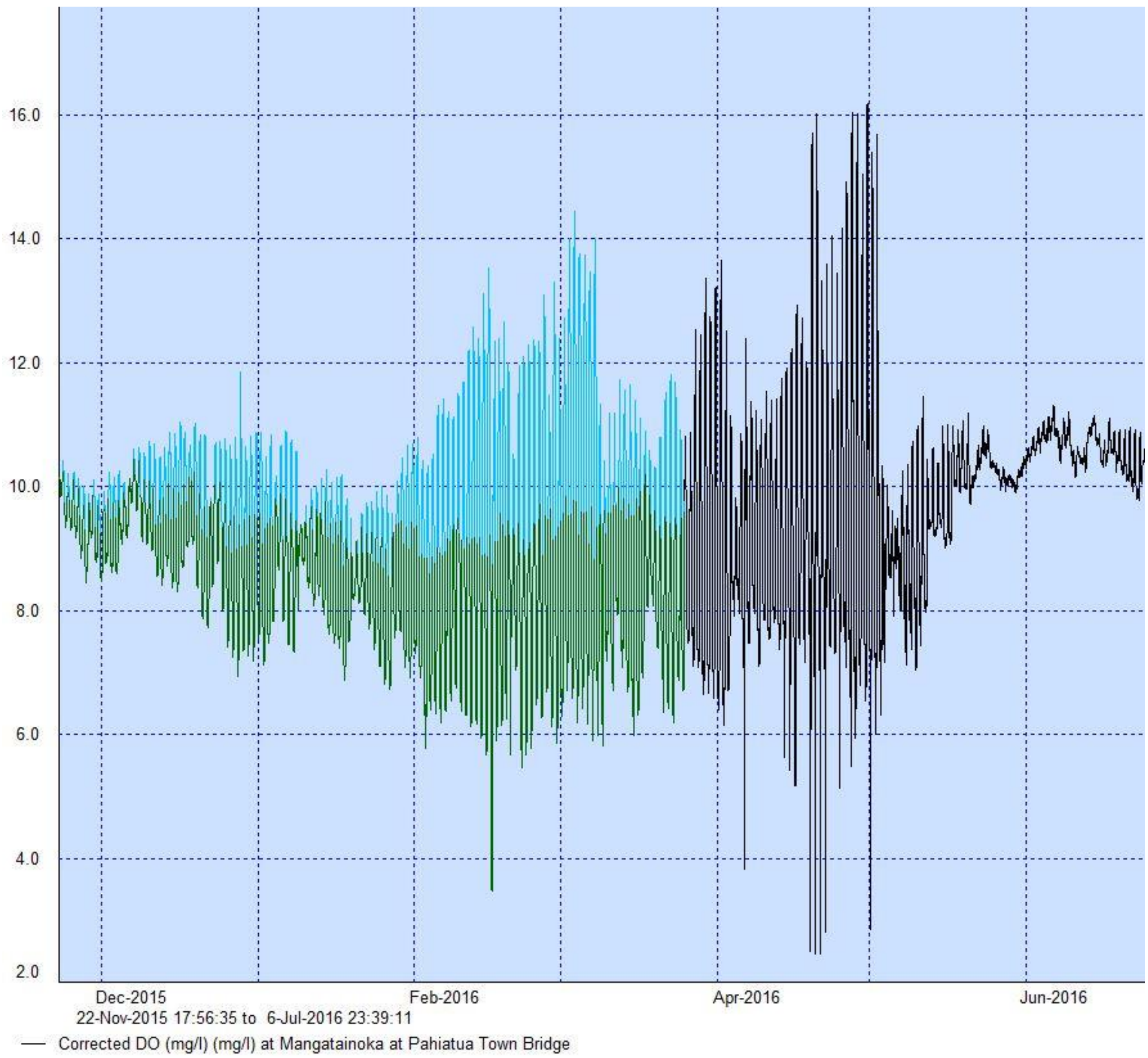

Figure 1: Dissolved oxygen concentrations (mg/l) as recorded at the Mangatainoka at Town Bridge from December 2015 to June 2016.

30. In relation to the Freshwater NPS the NPS does contain an attribute for DO for downstream of point source discharges. I have reproduced the table for this attribute below:

Value	Ecosystem health		
Freshwater Body Type	Rivers (below point sources)		
Attribute	Dissolved Oxygen		
Attribute Unit	mg/L (milligrams per litre)		
Attribute State	Numeric Attribute State		Narrative Attribute State
	7-day mean minimum[1] (Summer Period: 1 November to 30th April)	1-day minimum[2] (Summer Period: 1 November to 30th April)	
A	≥8.0	≥7.5	No stress caused by low dissolved oxygen on any aquatic organisms that are present at matched reference (near-pristine) sites.
B	≥7.0 and <8.0	≥5.0 and <7.5	Occasional minor stress on sensitive organisms caused by short periods (a few hours each day) of lower dissolved oxygen. Risk of reduced abundance of sensitive fish and macroinvertebrate species.
C	≥5.0 and <7.0	≥4.0 and <5.0	Moderate stress on a number of aquatic organisms caused by dissolved oxygen levels exceeding preference levels for periods of several hours each day. Risk of sensitive fish and macroinvertebrate species being lost.
National Bottom Line	**5.0**	**4.0**	
D	<5.0	<4.0	Significant, persistent stress on a range of aquatic organisms caused by dissolved oxygen exceeding tolerance levels. Likelihood of local extinctions of keystone species and loss of ecological integrity.

1. The mean value of 7 consecutive daily minimum values.

2. The lowest daily minimum across the whole summer period.

Figure 2: Freshwater NPS attribute table for dissolved oxygen.

31. In terms of needing to monitor compliance with the Freshwater NPS attribute it is my opinion that the monitoring responsibility should sit with the applicant in hearings such as this. The ability to be able to undertake campaign logging for DO is reasonably easy to undertake and improvements in technology are making meters more reliable and cheaper.

Appendix 1:

'Look-up tables' for maximum allowable exceedances (e) of a percentile standard's threshold for a given number of samples (n), for: a 50%ile (i.e., median, Tables 1 & 2); a 95%ile (Tables 3 & 4). The maximum tolerable error risk is taken as 5% (in line with current practice). Calculations have been made using results stated in references 2 and 8.

Table 1. Precautionary approach for compliance assessment with a median

e	*n*	*e*	*n*	*e*	*n*
0	3–5	8	25–26	16	43–44
1	6–8	9	27–28	17	45–47
2	9–11	10	29–31	18	48–49
3	12–14	11	32–33	19	50–51
4	15–16	12	34–35	20	52–54
5	17–19	13	36–38	21	55–56
6	20–21	14	39–40	22	57–58
7	22–24	15	41–42	23	59–60

Note that if there are less than 3 samples it is not possible to keep misclassification error risks below 5% when assessing a 50%ile standard.

Table 2. Permissive approach for compliance assessment with a median

e	*n*	*e*	*n*	*e*	*n*
0	1	10	14–15	20	31–32
1	1	11	16–17	21	33–34
2	2–3	12	18	22	35–36
3	4	13	19–20	23	37
4	5–6	14	21–22	24	38–39
5	7	15	23	25	40–41
6	8–9	16	24–25	26	42–43
7	10	17	26–27	27	44–45
8	11–12	18	28–29	28	46
9	13	19	30	29	47–48

Table 3. Precautionary approach for compliance assessment with a 95%ile

e	*n*
0	38–76
1	77–108
2	109–138

Note that if there are less than 38 samples it is not possible to keep misclassification error risks below 5% when assessing a 95%ile standard.

Table 4. Permissive approach for compliance assessment with a 95%ile

e	*n*	*e*	*n*	*e*	*n*
0	1–3	3	23–34	6	61–74
1	4–11	4	35–46	7	75–88
2	12–22	5	47–60	8	89–102